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ABSTRACT

The conceptual unification experiential (CUE) model was developed to provide a mechanism for flexible and adaptive development of instructional content for use in a large computer-based instructional system. The purpose of the CUE model is to provide subject matter experts with a framework by which they can create instructional contexts that encompass task oriented or job oriented goals. The model requires the identification of realistic training contexts, the content space of which is represented by three dimensions: (1) conceptual, (2) unification, (3) experimental. Instructional materials are developed for specific points in the three dimensional space. The example topic area in this report is electronic fundamentals and the approach taken is the application of a content analysis and instructional sequencing model, which combines content structure, aspects of the learning process, and the requirements of individualization to guide development of instruction. The result of applying the model is a performance oriented training context. (DAG)

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CUE Model for the Development of Training Contexts[1]

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[1] Paper to be presented at the 1977 AERA Convention, New York.

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One of the most important functions of instructional design is to determine an appropriate sequence or structure for conducting instruction. In the past, sequence has often been determined by historical precedent in a subject matter field rather than by instructional logic. More recent learning theorists (i.e., Bruner, 1966; Gagné, 1970) have stressed the learning process as a basis for the development of a curriculum. Still another recent trend is that models of the learning process or a discipline are being used rather than more encompassing theories (Berliner and Gage, 1976) to handle the realities of the classroom. In the military, instruction is moving more and more toward individualization and with this there is the question of whether or not a single sequence of content is sufficient. The project to be described is a recent on-going effort to develop individualized materials for one area of a large computer-based instructional system--the Air Force's Advanced Instructional System (AIS) (Rockway and Yasutake, 1974; Yasutake and Stobie, 1975). The topic area is electronic fundamentals and the approach taken is the application of a content analysis and instructional sequencing model which combines content structure, aspects of the learning

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process, and the requirements of individualization to guide development of instruction. The result of applying the model is a performance oriented training context.

The Need for Contexts

The AlS is basically a CMI system with a critical computer program called the Adaptive Model. This program serves to match instructional resources with individual student needs. A variety of instructional media are used including as examples programmed texts, filmstrips, videotape, CAI, etc. Using this basic concept of adaptability and flexibility, a development program was initiated for electronic fundamentals which would allow a logical methodology for matching levels of instruction to user's needs. The methodology grew out of the need to satisfy several requirements divergent in nature.

The first requirement was to produce a training program more effective in preparing students for concrete performance tasks subsequent to fundamentals instruction. This posed problems of retention and transfer of learning. The second requirement was to present subject matter knowledge sufficient to allow criterion performance levels to be reached without presenting information unnecessary or peripheral to the actual task requirements. This posed problems of selection and sequence especially when one still wants to foster an integrated understanding of the career field or subject matter. The third requirement was the arrangement of materials in a manner which allowed their use in achieving different levels of competency. This

posed problems of training analysis and packaging. The fourth requirement was to provide a means by which subject matter experts could organize their knowledge and skills in an efficient manner which would satisfy the previous three requirements. This posed problems in procedures, formats, and general instructional design.

The fourth requirement mentioned above is of particular concern because it gets at a significant problem in instructional design. How does one get subject matter experts to critically evaluate the content area in a systematic manner? Gropper (1976) highlighted this problem when he stated,

> "It is very easy for a grade school teacher or a college faculty member to think back to the education he received in his discipline or to inspect the table of contents in available texts in that discipline (however much admired) and to leap to the conclusion that that represents what a field is all about." (p 41).

Looking back from a position of expertise may obscure relationships which are important to a naive learner confronted with a new content area. The logical structure imposed by an expert who already has a strong assimilated cognitive structure for the content area could be quite inappropriate for a new learner.

Traditional electronics instruction has always arranged its content in a hierarchal manner. Gagné (1970) referred to the idea of working backwards from an objective through all prerequisite learnings, and in this manner deriving a map of what should be learned. But, Gagné's notion of prerequisite learnings really apply only to

intellectual skills (i.e., one must be able to add and multiply before dividing) and not necessarily to facts or principles. This distinction has been made by Gagne himself as well as others (White, 1973; Phillips and Kelly, 1975). Furthermore, Phillips and Kelly (1975) argue that hierarchical design is not a psychological issue as much as it is a logical issue better addressed by the experts in a subject area. Unfortunately, the concept of hierarchy is so attractive to practitioners and instructional designers that in the process of reducing a content area down to its "building blocks" they often do not know when to quit. Thus, in the area of electronics, as one example, practical performance tasks associated with analyzing and troubleshooting a basic voltage divider circuit can get reduced down to a discussion of electron physics.

Merrill (1976) as an alternate to Gagne's learning hierarchies proposed concept elaboration or "elaboration theory." This proposition entails viewing content as a network of nested levels, each adding a dimension of complexity to a concept, operation, or rule. Elaboration theory breaks away from the singularity of progression characteristic of a hierarchy and instead recognizes the dual effect of prerequisite and consequent on each other. Concept A may be prerequisite to Concept B, but the acquisition of B impacts and alters the understanding of A. A hierarchical approach to content may oversimplify and even eliminate important inter-and intra-relationships in a content area. The word elaboration is quite

appropriate because it conveys an unfolding of knowledge or understanding which is more descriptive of how people cope with new contexts than the idea of nice discrete steps implied by hierarchies.

The results of the behavioristic movement in psychology has taught us that people respond to and to a certain extent are controlled by their environment. The more recent cognitive movement is accruing evidence that responses to an environment are mediated by the manner in which people perceive and organize the inputs from that environment. The cognitive structure of an individual can have profound effects on the learning from and the response to a particular instructional environment. Noddings (1976) raises the issue that if cognitive structures develop in stages, with each level or stage nested in more elaborate levels or stages, then the most elaborate structure of a discipline, the one which encompasses fundamentals, would be quite inappropriate for the new learner. As he states,

> "Its very assessment as 'fundamental' warns us that the novice will not possess the structure to grasp it, for the understanding of <u>fundamentals qua fundamentals</u> is the hallmark of mastery." (P 20).

Pask's (1976) Conversational Theory is a systematic means to capture the structure of a content area or topic held by subject matter experts. One of its most salient aspects is the recognition that the understanding of a content or subject matter area held by an expert is unique to that individual, yet is neither better nor worse than that of another expert. As Pask states,

> ". . . the resulting structure describing say 'optics,' is merely the expositor's thesis on optics. It is not

> optics in any ideal sense; the thesis represents only the personal construction of one or more expositors." (P 16)

Pask's technique basically is to draw out of experts their conception of a task or content area, and then "average" these separate conceptions and reduce or prune them to essential elements to produce a single refined representation of the task or content area which is called an Entailment Structure. One of the major benefits of Pask's work is that it provides a means by which subject matter experts can formulate and critically examine their conception of their area of expertise.

Good instructors have long recognized that learning is aided by having instruction relevent to the needs and perceived goals of students. Unlike general education, training and specifically military training, has the advantage of specific jobs which can readily provide learning goals for students. Job tasks are analyzed to determine instructional content, but the sequence and form of instruction does not always reflect the nature of the tasks or jobs, especially in areas of instruction called "fundamentals." Cason (1975) in describing an information processing approach to organizing instructional content states as his first principle, "Instructional content should be organized in terms of over-all job plan, i.e., a finely differentiated, integrated set of job goals and methods for reaching these goals." Content organized on the basis of job goals fits the principle of establishing instructional contexts.

Noddings (1976) in further discussing the issue of fundamental principles in organizing content comes to this conclusion,

> "My point here is that students (all of us) learn to generalize over a limited context, and it takes much intensive and extensive experience to understand fundamental principles as fundamental principles." (P 21)

The CUE Model

The purpose of the CUE Model is to provide subject matter experts with a framework by which they can create instructional contexts that encompass task oriented or job oriented goals. Furthermore this development model rejects the notion of "traditional hierarchy" which simply analyzes content into a series of unidimensional elements independent of a specified goal or context.

To properly represent a contextual reality as a vehicle for instruction, subject matter cannot be structured along a single dimension, but rather should be represented by at least a three dimensional space. This instructional space takes account of conceptual organization ranging from attributes or structure to rules or process, it takes account of the unification of knowledge, that is a topic can exist as a whole and as a part simultaneously, and finally it accounts for the mediating effects of experience (immediate or past) on the acquisition of knowledge. A representation of the three dimensional space for a training context is shown in Figure 1.

Insert Figure 1 about here

The Conceptual, Unification, and Experiential (CUE) dimensions which make up the development model were labeled with terms which by concensus were meaningful to the instructors assigned to the development of the electronic fundamentals program. These labels for the three dimensions respectively were Structure-Product-Process, Whole-Part, and Tangible-Intangible. The labels represent generalized extremes of a continuum rather than specific, discrete points. There are different levels of Structure, Wholeness, Tangibility, etc. The labels were chosen for their descriptive relevance to subject matter experts rather than for any adherence to a particular theory of concept attainment.

The first or Conceptual Dimension could be represented in a variety of ways. For example, Merrill and Boutwell (1973) classified conceptual content in the following major categories. Paired-Associate, Concepts, Principles (operations) and Problems (combination of principles). Klausmeier, Ghatala, and Frayer (1974) referred to the concrete, identity, classificatory, and formal levels of concept attainment.

Pragmatically, a person confronted with a new situation attempts to give meaningful structure to the new situation by identifying the characteristics and attributes of the situation. These attributes are grouped together for convenience to form concepts. As more order is imposed on the situation, a person moves beyond structure to basic relationships and manipulations. If A is present, then B will occur. A person begins to manipulate the environment (operation)

and note the result (product). Further awareness causes simple manipulations to be refined such that if A occurs, then A' and A" follow, and then B, or if A, then B, C, and D. A multiplicity of elements or events are now manipulated by the person such that the original observed situation is processed at an increased depth of perception or understanding.

The terms structure, product, and process were borrowed from work done on the Air Force's Electronics Principle Inventory (O'Conner, 1976) an instrument used to assess the amount of electronic knowledge used by technicians in the performance of their tasks. As mentioned earlier, these terms have a degree of descriptive meaning as related to a problem or performance context. In addition, they convey a sense of increasing manipulation of the context. Table 1 represents a set of question forms given to subject matter experts (SMEs) to help them elicit the appropriate conceptual information about a particular content and specifically a particular context. Appendix 1 shows an example of the results of applying these questions to the context of an electronic rectifier circuit.

Insert Table 1 about here.

The listing of items in Appendix 1, upon closer inspection, should reveal the involvement of the other two dimensions in the CUE Model--the Unification and the Experiential Dimensions. The Unification Dimension's purpose is twofold. First it forces SME's to consider

content and context, first as a whole, and secondly in terms of its parts. Though this is similar to the process of developing a hierarchy, strict hierarchical instruction reverses the process of content analysis for instruction. This approach can typically result in the forest not being seen for the trees. With the Unification Dimension content analysis and instruction are forced to proceed from whole to part. In addition, the Unification dimension tends to force a Gestalt for each element of content. For every element of content, that element can be conceptually handled on the basis of structure, product, and process and each element is simultaneously a whole and a part. Thus, the content element called rectifier circuit is a whole and also a part of another whole called a power supply.

The notion of using the concept of cognitive structure to describe an individual's ability to process information is a mentalistic way of also referring to the sum total of an individual's experiences. In behavioral terms, all individuals respond to the environment or context in which they find themselves. A response is reinforced to the degree that it allows the individual to cope with the context and this in turn solidifies the internal structure which caused the response to be emitted. If the environment changes in a significant way, then the individual's response patterns become inappropriate or in other words, the individual is utiiizing an inappropriate strategy. For the time

being, the only way a person's strategy for coping can be represented is in terms of the context or environment which forced application of the strategy and the person's responses based on the use of the strategy.

As an addition to Bloom's Cognitive and Affective taxonomies, Steinaker and Bell (1975) have proposed an Experiential Taxonomy. The idea of an Experiential Taxonomy recognizes that the individual in most instructional situations is a given and that the instructional environment needs to start where an individual is. This is the function of the Experiential Dimension in the CUE Model. The labels tangible-intangible convey that reality begins with those things which can be readily sensed and progresses to those things which must be abstracted. A corollary to the idea of tangibility is the idea of familiarity; thus, the Experiential dimension can additionally be labeled familiar-unfamiliar.

In Figure 1, content would be analyzed into a set of points that traverse the three dimensional space. However, in all cases, instruction would start with those points closest to the lower, left junction of the three dimensions and proceed to the right. In Merrill's terms, instruction would become more elaborate. The triangular area in Figure 1 symbolically represents this idea of elaboration and does not imply that all content points would fall on a simple plane. In terms of the information shown in Appendix 1, the progression of content is

down the structure column until there is product and/or process information, then across, and then back to structure and down another level.

Establishment of Contexts

The CUE model provides a series of shaping contexts (environments) which allow students to achieve their own cognitive structure of a particular content area through their own experiences with a well defined context. (i.e., There is no one absolute way to troubleshoot a particular device). A context is called a functional unit which is a coherent representation of some real performance aspect of a career field or subject matter; thus, it can be an actual piece of equipment from the career field or it can be a unique trainer which represents characteristics common to several pieces of career field equipment. A functional unit should not be thought of as simply equipment, but can just as well be thought of as problem areas within a field of content. The major requirement for the functional unit is that it provide a complete and realistic performance environment for the student. Functional units are sequenced in an order of increasing complexity.

As already discussed, each context is seen as being three dimensional in nature. However, two additional features characterize a training context in the CUE Model. The first is that the context is goal oriented and the second is that knowledge be subordinated to performance. Content analyses and instructional development follows the flow diagram shown in Figure 2 and is supported by the forms shown in Appendix 2.

Subject matter experts go through the following process to establish training contexts. The existing curriculum (electronic fundamentals) is classified into a series of functional units, the total accomplishment of which would insure that students will have a functional understanding of the subject area. Each functional unit is described in terms of goals to be accomplished by the student completing the functional unit. The goals are then formalized into measurable behavioral objectives. In the case of electronic fundamentals, the behavioral objectives are classified on the basis of circuit analysis and troubleshooting, these being the two major performance areas of concern.

After all functional units are defined, they are each analyzed into Sub-Units. This part of the process is fairly arbitrary and is based in part on perceptions of what is a manageable unit of instruction prior to having a test of student progress. The decision as to whether or not to have sub-units is also based on the degree of integrity desired at any point. A sub-unit is by no means necessary. As an example, a power supply may be considered a functional unit, with rectifier circuit, filter circuit, and regulator circuit being sub-units. Alternately each of the previous sub-units can be considered as functional units. Which way to classify should be greatly determined by points of emphasis derived from actual job tasks. For example, if job emphasis is on equipment removal and replacement, the first classification scheme would be appropriate.

However, if job emphasis is on circuit troubleshooting and component replacement, then the second classification scheme would be more appropriate. If sub-units are established, each sub-unit goal is stated and specific performance objectives are written for the sub-unit.

Assessing the goal descriptions and behavioral objectives for the functional units and their sub-units, a listing of knowledge topics which support the performance objectives is made using the form labeled Theory/Knowledge Descriptor Sheet (Appendix 2). The depth of coverage for each topic is tentatively indicated by a check mark in either the Structure, Product, or Process columns. An important part of the analysis process is to get subject-matter experts to assess the totality or breadth of the subject area before there is any concentration on detailedness.

After the Theory/Knowledge Descriptor Sheets are completed for each topic, knowledge objectives are written for the topics and listed on Lesson Information Sheets (Appendix 2). With this step, all inter-unit sequencing and definition should be completed. Intra-unit sequencing is guided by the flow diagram shown in Figure 2. It is important to emphasize that the flow diagram applies to a <u>whole</u> unit, and thus may cut across several lessons. The designation of a lesson is mainly determined by administrative and testing requirements.

In accordance with the flow diagram, each unit begins with an overview that is a non-technical description which establishes the

goal for the unit and serves as an advance organizer. Specific support knowledge are sequenced in accordance with the CUE Model previously discussed and the completion of Lesson Outlines as shown in Appendix 1. All knowledges and sub-skills taught in a Unit are brought together and synthesized by performance tests or workbooks to accomplish the performance objectives first stated for each unit.

Final Considerations

The Air Force training environment has provided the impetus for developing the CUE Model. To this extent the model is directed to an instructional environment which must produce trained personnel capable of performing a defined level of job competency and do this in relatively short periods of time. Training must be cost-effective and a corollary to cost-effectiveness is the idea of sufficiency. Training which exceeds proscribed levels of competency will be wasteful in both human and instructional resources. The CUE Model, through its use of context and three dimensional representation of content forces sufficiency in instruction. However, the notion of sufficiency in instruction is simply a response for the need to be practical. (For further discussion of the notion of sufficiency, see Newell and Simon, 1972.) Rather, sufficiency also takes into account that the human learner has limited capacities for processing information (Miller, 1956; Simon, 1974). Sufficiency is a two edged sword. On the one hand it reaps administrative benefits by limiting needless instruction,

and on the other hand it reaps psychological benefits by producing a more manageable learning task for the student.

The potential benefits of applying the CUE Model are threefold. First, because a particular context is well defined in terms of real and practical situations or tasks, students learn basic knowledge and skills in a manner that allows their immediate application. Immediate and successful application reinforces the student's responses to the environment. This in turn solidifies the internal cognitive structures which produced the responses. Noddings (1976) stated this process nicely:

> Understanding does not precede doing; it emerges out of the mastery of practical tasks. (p 45)

The use of context to serve as a carrier for basic knowledge and skills additionally serves as a filter for the subject matter expert. Borrowing terminology from Pask (1976), the context and its specific performance goals forces a pruning of the subject matter space such that "nice-to-know" , unessential content becomes obvious.

Pruning is further aided by the internal structure of the context which demands a three dimensional consideration of content. Earlier it was stated that the CUE Model rejected the concept of a "traditional hierarchy", yet progression along the three dimensions seems to imply a form of hierarchical arrangement. Hierarchy as a generalized, logical method of ordering and structuring complex systems is not rejected but rather the singular notion of subordinate relationships is rejected.

A neutral conception of hierarchy which focuses on a multiplicity of relationships is an important distinction made by Simon (1969) in his book The Sciences of the Artificial . In analyzing electronics, a circuit is composed of its components, the components are composed of materials, and finally the materials are composed of molecules and atomic particles. However, there is no reason that instruction on the smallest division of the described complex need precede the largest division. Seen in this light, fine level discussions of content are not really necessary antecedents to grosser level discussions. Understanding a rectifier circuit as a total unit is an independent learning function from understanding a rectifier circuit as a set of replaceable components.

What is created by using the CUE Model for content analysis is a three dimensional hierarchy that provides a certain multiplicity of linkages between its components. Simon (1969) referred to this as the concept of near decomposability of a complex system. One of his examples gives further clarification:

> In studying the interaction of two large molecules, generally we do not need to consider in detail the interactions of nuclei of the atoms belonging to one molecule with the nuclei of the atoms belonging to the other. In studying the interaction of two nations, we do not need to study in detail the interactions of each citizen of the first with each citizen of the second. (pp 107-108)

The CUE Model is intended to give a structure which will clarify and then minimize instruction on needless relationships or topics in the accomplishment of stated goals.

The second benefit of the CUE Model is that its representation of content as sets of points in three dimensional space allows for a high degree of individualization of instruction. Each point is independent and yet related to other points in the three dimensional space. The atomic properties of an electron (structure, part, intangible) are related to the concept of electricity and its effects (product, whole, tangible/familiar) and yet electricity can be discussed independent of the atomic properties of electrons. Given the assumption that different learners react to and order their environment in different ways, instruction consisting of different combinations of points within the three dimensional matrix of the CUE Model can be used for different types of learners. In computer-based instruction, learners may be matched to a certain path through the content space or a degree of learner control may be allowed for the student to find his own path.

The third and most immediately relevant benefit of the CUE Model is that it provides a heuristic which tends to simplify complexity. The model, in its present form has sufficient structure and demands specific products to allow course developers to handle a flexible and complex content program in an efficient and orderly manner. The

present form of the CUE Model is meant to be used in a paper and pencil mode as well as heuristically. In part this is one reason why the three dimensions are not further elaborated. Future and more refined use of the model will require computer support in order to state and manipulate the multiplicity of variables. However, in its present form a group of military instructors have used the model to perform a systematic content analysis of electronic fundamentals for an individualized course in sophisticated electronics training. At least intuitively, the CUE Model has provided subject matter experts and instructional designers in the Advanced Instructional System development effort a means of critically evaluating the structure and content of one area of technical training. Hopefully, future development of the model will continue and expand its usefulness for the development of individualized training contexts.

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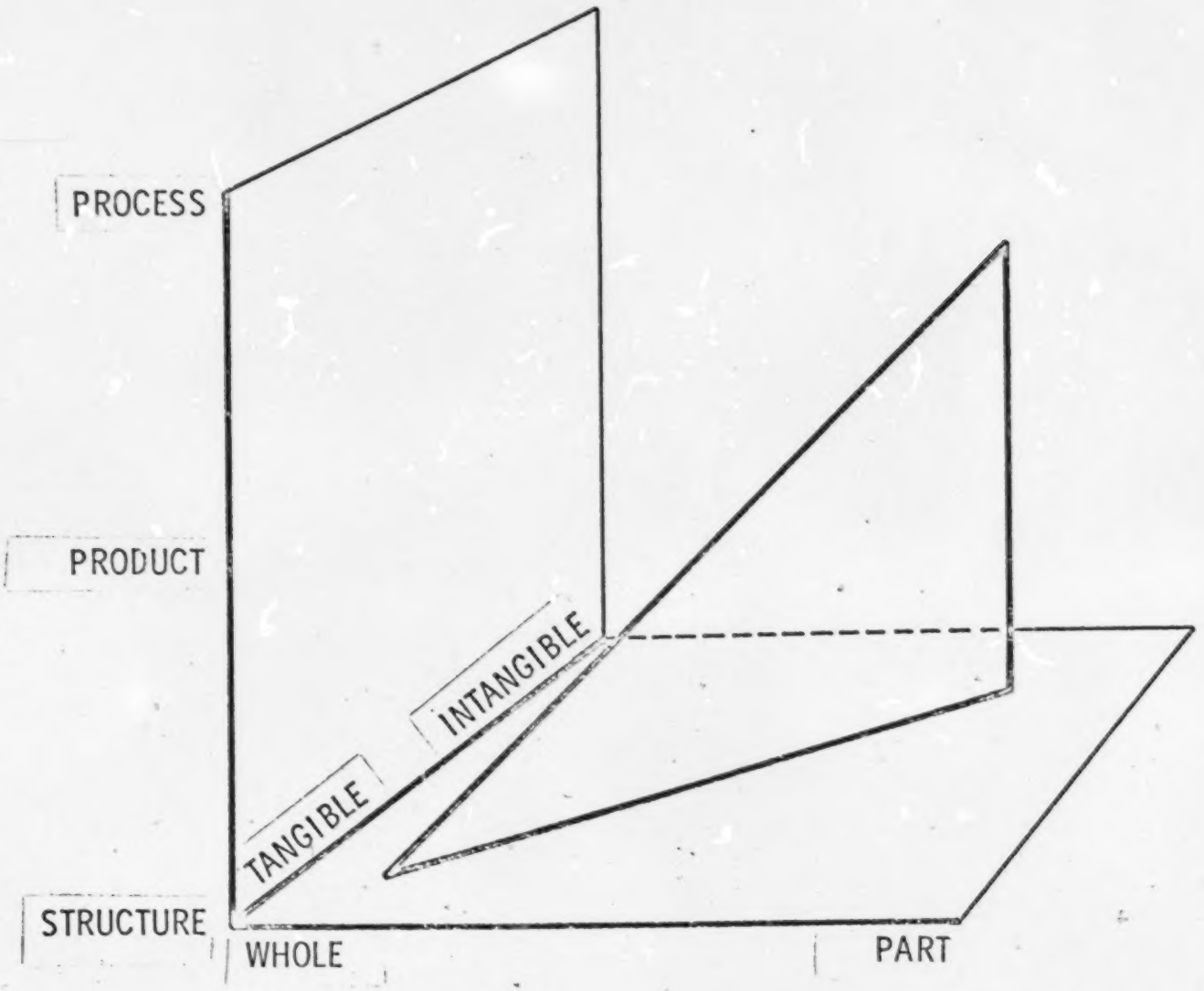

Figure 1 - The CUE Model Content Space

COMMON ELECTRONIC FUNDAMENTALS DEVELOPMENT MODEL

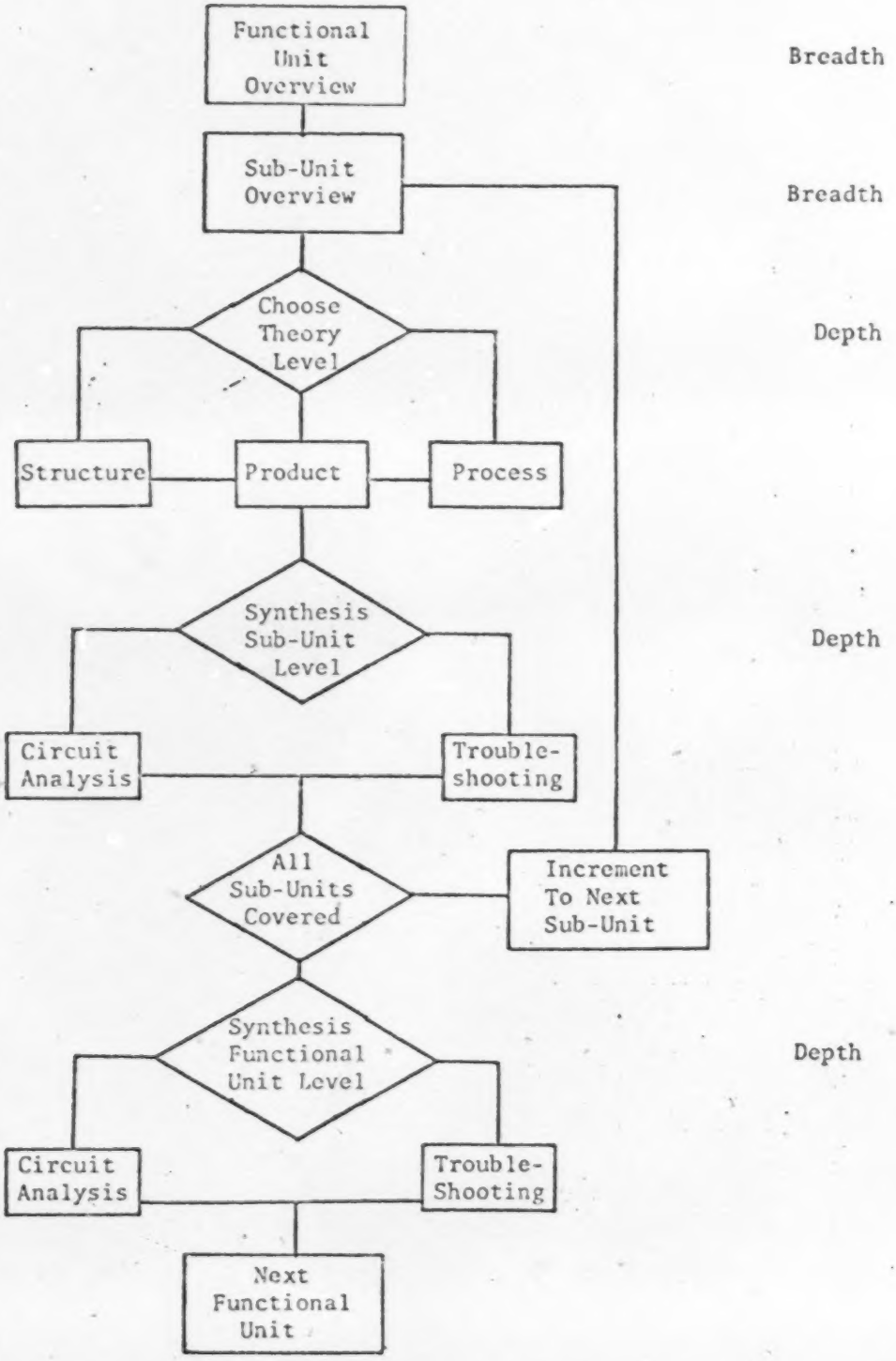

Figure 2 - Sequence Flow For Instructional Development Within a Context for the CUE Model

Title	Structure	Product	Process
Descriptive Nouns	Description & Utilization	Relationships & Results	Detailedness & Analysis
Questions	What is this? What is its use? What does it look like? Why is it used? Where is it used? When is it used? When is it done?	If this occurs what(then) happens?	How does it work? Why does it work in this manner? If this occurs why does this or that happen?

Table 1 - Example Questions to Elicit Structure, Product, and Process Levels of Content Information on the Conceptual Dimension

APPENDIX 1 - Example of the Conceptual Levels of Content for a Rectifier Circuit

TANGIBLE/WHOLE	STRUCTURE	PRODUCT	PROCESS

What do typical rectifier circuits look like?

There are three types of basic rectifier circuits. The most simple is the half-wave circuit which looks like this: It is called half-wave because it passes only half of the input sine wave. . . etc.

What are the major components of a rectifier circuit?

The major component of a rectifier circuit is a diode. Some rectifier circuits also require an input transformer which is center tapped.

What is rectification?

Rectification is the conversion of an AC input to a pulsating DC.

What does pulsating mean?

Pulsating means that the DC is not constant but changes in amplitude.

If a sine wave is applied to a rectifier circuit, what is the output?

The output of a half-wave rectifier is this: One DC pulse for every AC cycle. The output of a full-wave rectifier is this: 2 DC pulses for every AC cycle.

TANGIBLE/WHOLE	STRUCTURE	PRODUCT	PROCESS

What is a diode?

A diode in our present application is a solid state device consisting of two sections of material called the emitter and the collector. Its schematic symbol looks like this:
It physically looks like this:

What is forward bias?

Forward Bias is when a negative potential is applied to the emitter of a diode and a positive potential is applied to the collector.

What is reverse bias?

Reverse bias is when a positive potential is applied to the emitter of a diode and a negative charge is applied to the collector.

If a sine wave is applied to a diode what happens?

If a sine wave is applied to a diode then a forward bias is applied to the diode for one alternation of the sine wave. This alternation passes through the diode as a DC pulse. The other alternation reverse biases the diode and is not passed through.

How is full wave rectification produced?

Full wave rectification is produced by having two diodes, one of which is always forward biased by either a positive or negative alternation of a sine wave.

TANGIBLE/WHOLE	STRUCTURE	PRODUCT	PROCESS
	What is a center tapped transformer? Show schematic and physical unit.	If a sine wave is applied to the primary of a center-tapped transformer, what is the output of the secondary? If a sine wave is applied to a center tapped transformer, then the center tapped lead to the secondary will always be negative in relation to the end lead of the secondary which is positive for any one alternation.	Why would a conventional (center tapped transformer full-wave rectifier put out only a half-wave D.C. waveform? A half-wave shape from the output leads of a conventional full wave rectifier would mean that one of the transformer secondary's leads is open (least likely) or one diode is bad (most likely).
	What is P material? P material is a semi conductor material in which there is an abundance of positive charges		How is P material formed? P material is formed by adding impurities (called doping) to a material such as germanium. . . etc.
	What is N material?		How is N material formed?
	What is a potential barrier?		How is a potential barrier formed?

INTANGIBLE/
PART

APPENDIX 2 - Forms Used to Establish a Context and Perform a Content Analysis For The CUE Model

FUNCTIONAL UNIT DESCRIPTOR SHEET

TITLE Voltage Divider Circuit CODE 1-1-Ø

DESCRIPTION:

The student will learn to identify the three basic circuit types, series, parallel, and series-parallel, in the context of a typical voltage divider circuit. In terms of the three types of circuits the voltage divider circuit the student will analyze current, voltage and resistance relationships and will be able to use both Kirchoff's and Ohm's law formulas to perform circuit analysis. The voltage divider circuit will give the student hand's on experience with basic measurement techniques and the use of basic troubleshooting procedures such as the split-half technique. It is important that the student start to become comfortable with schematic diagrams as symbolic representations of actual circuit configurations and the peculiar features of their physical layout.

OBJECTIVES:

CIRCUIT ANALYSIS

A. Given a schematic diagram of a voltage divider circuit, identify what the correct circuit values should be at selected measurement points for a given set of circuit conditions. 90% of the identifications must be correct

B. Using a multimeter and given a voltage divider circuit, measure the voltage and current between given pairs of measurement points. The measured values must be within ± 5% of the instructor's readings

TROUBLESHOOTING

c. Presented with three instances of a voltage divider circuit which is malfunctioning, use a multimeter to take selected measurements, recording those measurements and indicating the malfunctioning component(s).

THEORY/KNOWLEDGE DESCRIPTOR SHEET

FUNCTIONAL UNIT Voltage Divider Circuit

SUB-UNIT _____

TOPIC	STRUCTURE	PRODUCT	PROCESS
1. Series Resistive Circuit			
a. Measurements with a multimeter	x	x	
b. Resistors	x		
c. Switches	x		
d. Voltage, Current, and Resistance	x	x	
e. safety devices	x		
f. DC voltage sources	x	x	
g. electron flow	x		
h. Troubleshooting	x	x	
2. Parallel Resistive Circuit			
a. Measurements	x	x	
b. Voltage, Current and Resistance relationships	x	x	
c. Circuit configurations	x		
d. Troubleshooting	x	x	
3. Series-parallel Circuit			
a. Measurements	x	x	
b. Voltage, Current and Resistance relationships	x	x	
c. Circuit configurations	x	x	
d. Troubleshooting	x	x	

SUB-UNIT DESCRIPTOR SHEET

FUNCTIONAL UNIT Voltage Divider Circuit

SUB-UNIT TITLE Series Resistive Circuit CODE 1-1-1

DESCRIPTION:

The student will be introduced to the basic properties of an electrical/electronic circuit. Emphasis will be given to the properties of a circuit and to the identification of circuit components such as resistors, control devices, safety devices, DC power sources, conductors and insulators. Introduction to the use of a multimeter will be made in this unit. The student will learn to use Ohm's law to determine unknown circuit values in the series circuit. The student will also use Kirchoff's series law. The student will perform elementary troubleshooting on the series circuit.

OBJECTIVES:

CIRCUIT ANALYSIS

A. Given a schematic diagram of a series resistive circuit, identify what the correct circuit values should be at selected measurement points for a given set of circuit conditions. 80% of the identifications must be correct.

B. Use a multimeter to make selected voltage and current measurements on a series resistive circuit. The measured values must be within $\pm$ 10% of the instructor's readings.

TROUBLESHOOTING

C. Using a multimeter correctly troubleshoot a sereis resistive circuit to the malfunctioning component.

TRAINING ANALYSIS
TEST ITEM DESCRIPTOR SHEET

FUNCTIONAL UNIT Voltage Divider Circuit

SUB-UNIT Series Resistive Circuit

OBJECTIVE 1-1-1-B

TEST ITEM #	TEST ITEM STEM	CORRECT ANSWER

Refer to Figure 2. The student will use a multimeter to accomplish the following performance items.

1. Following proper safety and operating procedures, measure the resistance of resistors R_1, R_2, and R_3. Fill in the table below.

	Resistance	
Designated	Measured	Range Used
R_1 =	R_1 =	
R_2 =	R_2 =	
R_3 =	R_3 =	

2. Following proper operating procedures, the student will make the voltage measurements between the points listed in the table below and will complete the table.

Voltage	Meter Range
H-Z =	
F-H =	
C-F =	
C-Z =	

3. The instructor will check the readings in the above table and then will observe the student measure total current through the circuit.

I_T = _____

LESSON INFORMATION SHEET

Course ØØ3 Block 1 Lesson 3 Prerequisite Lessons none

F.U.	S.U.	UNIT OBJ	K/T TOPIC	STS	KNOWLEDGE/ENABLING OBJECTIVE	T.I. #	ST	PD	PC	Media Code	Crit.
1	1	B	1a		2. Given several expected circuit values, identify the appropriate multimeter range and function switch settings for proper measurement of each value. 80% of the identifications must be correct	9-18	X	X		WB	3

Lesson # 1

LESSON OUTLINE

Unit 1-1-1-A

STRUCTURE

PRODUCT

PROCESS

TANGIBLE/ FAMILIAR- WHOLE

What do series resistive circuits look like?

What is a series circuit?
- a. defining physical characteristics
- b. defining electrical characteristics

What are the minimum components which make up a working circuit?

What functions do these components fulfill for the series circuit?
- a. voltage source
- b. conductors & insulators
- c. load
- d. control devices
- e. safety devices

What is a primary battery?

What is a secondary battery?

Why are two different types of batteries used?

what is a resistor?

Why do we use resistors?

What identifies a resistor?

INTANGIBLE/ UNFAMILIAR- PART

cont.

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